EMU-CSC Commissioning

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FNAL

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CERN – Sep 14th, 2003

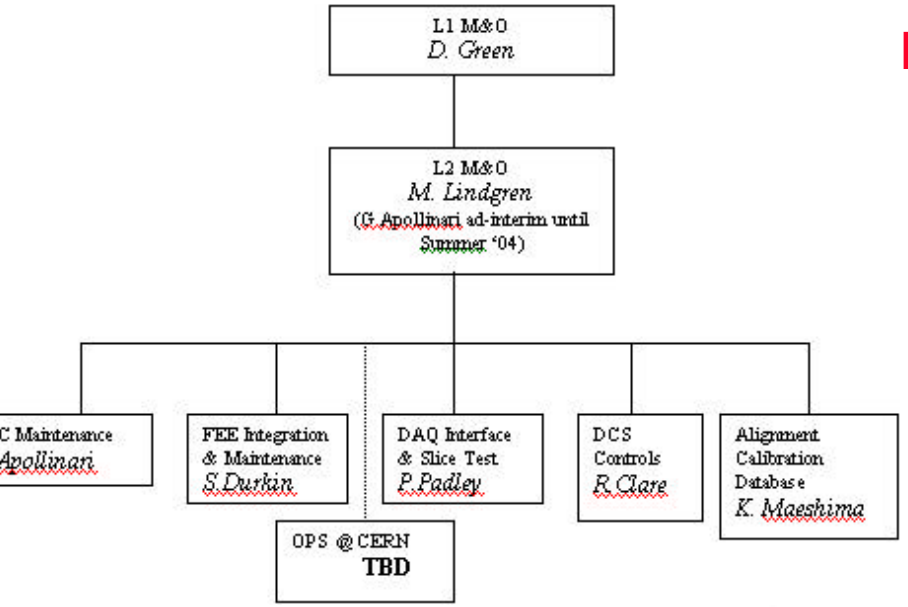
Outline

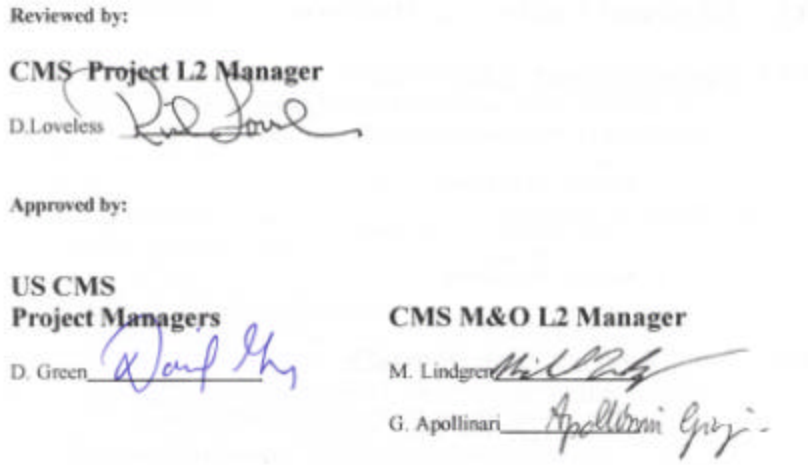
- **Introduction**
  - Maintenance and Operation (M&O) Phase Description
  - Scope and Deliverables of M&O Phase
  - High-Level Schedule
- **M&O Phase Planning**
  - Phases and their Description
  - Manpower Resources
  - Major Milestone
- **Conclusions**

M&O Phase - General Scope

- **Commission CSCs, FEE & Peripheral Electronics**
  - Define Project Completion
    - Full Installation up to and including connectivity tests
  - Operate CSCs, FEE & Crates as HEP Detector
    - Gas, Cooling Water (CSCs & Crates), HV, LV, ….
  - Read out EMU (DAQ System)
  - Control EMU (DCS System – see Clare's talk)
- **Slice Test**
  - From "Cosmic μ " to "Mass Storage"
    - Track ↦ Trigger Primitives ↦ DAQ Chain ↦ Physics Object
- **Slice Test ↦ Operation**
  - i.e. from *"Part of the Detector working some of the time"* to *"All Detector working all the time"*

M&O Phase Management Structure





Maintenance & Operation:

- Direct line of management structure with main L3 tasks:
  - CSC Maintenance
  - FEE Integration & Maintenance
  - DAQ Interface and Slice Test
  - DCS Controls
  - Alignment, Calibration & Database
  - Operations
- US CMS, IHEP China and PNPI Russi will share responsibilities for th commissioning of the ME2, ME3 an ME1/2-ME1/3 system.
- Weak point: ME1/1 Commissioning not ye fully integrated in CSC-M&O phas although, obviously, no success can b can be achieved without ME1/1.
  - Homework for next few months.

M&O Phase Scope of Work

CMS EMU M&O Phase
Guidelines, Responsibilities & Scope of Work

November 11th, 2002
Final Version

This **CMS EMU Maintenance & Operation (M&O) Phase – Guidelines, sponsibilities & Scope of Work** document covers the description of tasks and ponsibilities for the L2 and L3 management in the context of the M&O Plan eparation. L3 Managers will use this document to further finalize the M&O activities d resource loaded schedule.

The document is split in five subsections according L3 subdivision of the M&O oject. Each L3 subsection contains the following self-explanatory items:

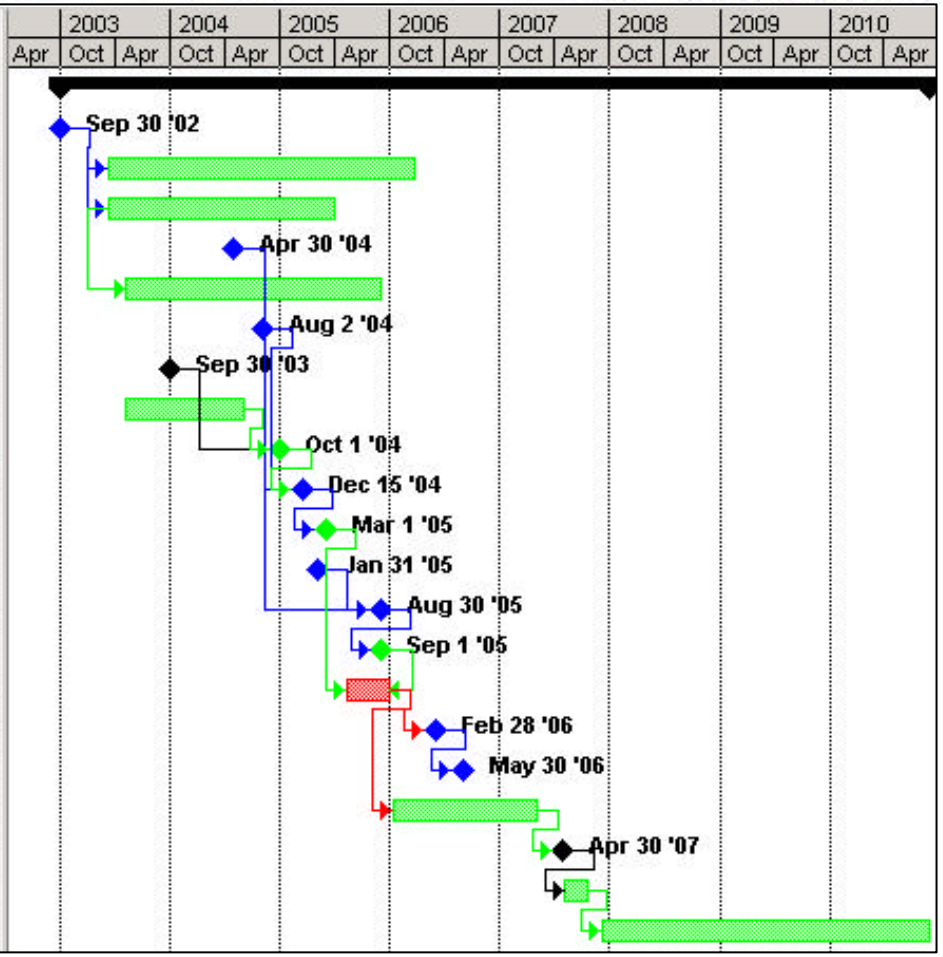
- *Expected Deliverables from Project Phase*
- *Overall Goals and Major Deliverables*
- *Major Milestones*

The L3 Activities and Responsibilities section provides the major input to the L3 anagers for the development of the M&O Project file. Every Manager is expected to velop a roadmap to deliver the products and services listed in the respective *Overall oals and Major Deliverables* subsections, as well as an expanded schedule for that admap following the guidelines provided by the *Major Milestones* subsection.

- The M&O Scope of work is described the document *"CMS EMU M&O Ph Guidelines, Responsibilities and Scope Work"*.
- The document lists:
  - Expected Deliverables from the Proj phase
  - M&O Deliverables
  - Major Milestones
- Concurred on by US-L2 Project Manag as well as L1-L2 US-M&O Managers.

M&O Major Milestones vs. V33 Milestones

Task Name	Start
CMS EMU Milestones	**Mon 9/30/02**
ME23/2 CSC's to CERN for SX5 Installation	Mon 9/30/02
Address Integration and Noise Issues (FEE)	Mon 3/3/03
Commissioning of CSC on Disk	Mon 3/3/03
ME2 and ME3 stations Installed	Fri 4/30/04
Services (Gas, HV, LV, Water) to CSC	Thu 5/1/03
ME+1/2, ME+1/3 Ready to Install	Mon 8/2/04
EMU Trigger Production	Tue 9/30/03
Slice Test Development Activities	Thu 5/1/03
Slice Test Completion	Fri 10/1/04
End ME SX Installation on YE+	Wed 12/15/04
YE+ Operations" in SX5	Tue 3/1/05
ME-1/2, ME-1/3 Ready to Install	Mon 1/31/05
End ME SX Installation on YE-	Tue 8/30/05
YE- "operations in SX5	Thu 9/1/05
YE lowered in UX5	Mon 5/2/05
End UX Inst/Cabling on YE+	Tue 2/28/06
End UX Inst/Cabling on YE-	Tue 5/30/06
Commissioning in UX5	Mon 10/3/05
CMS Ready	Mon 4/30/07
CMS - Pilot Run	Mon 4/30/07
CMS - Physics Runs	Thu 8/30/07



- **Project Milestone (V33)**
- **US M&O Milestone**
- **P5 Infrastructure Milestone**

EMU - CSC Commissioning at a Glance

Phase I	When	Who
• Detector Status	Now	~Installation Crew
• Connectivity & Dead Channels	Oct.-Nov.	~Installation Crew
Phase II		
• “FAST Site Testing” of CSCs	Winter ’03-04	Commission Crew
Phase III		
• Peripheral Crates DAQ	Summer ’04	DAQ/DCS Crew
Phase IV		
• Counting Room Crates	Spring ‘05	DAQ/Trigger Crew
• Full EMU System		

CSC Commissioning – Phase I

Goals

- Basic mechanical and electrical confirmation that the “chuncks” of metal and plastic hanging on the YE disks are indeed likely to work as particle detectors:
  - No broken wire or gas leaks, no breakdown under limited HV (~1kV)
  - Piping cross-checks (Water/Gas), Cable Connectivity/Dead Channels checks.

Planning/Status

- First draft plan circulated. Activities being defined and starting in SX5

Needs

- Access to disk (coordinate through the CSC Installation Group) + Portable DAQ & Power Supplies.

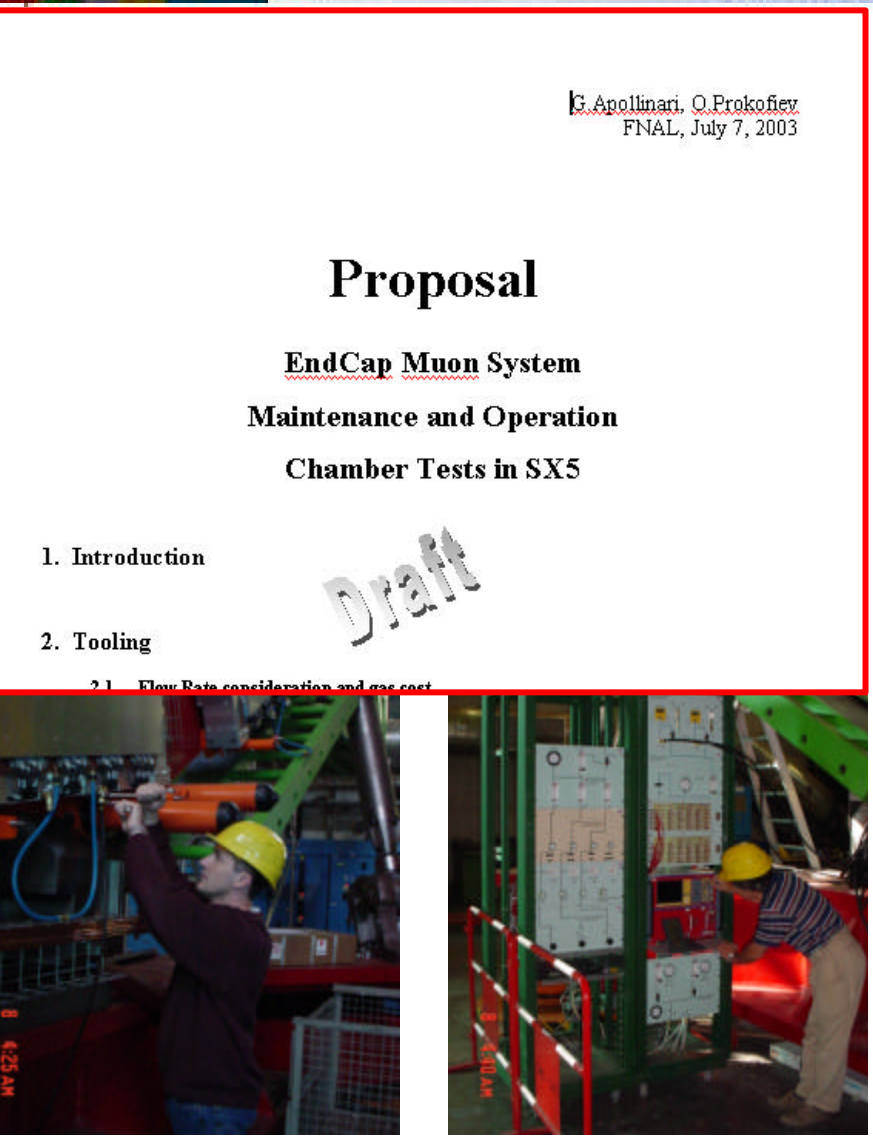
Who

- US EMU Group - (Purdue U., FNAL, UC Davis, UCLA, PNPI, IHEP)
  - Complementary to Installation Effort (i.e. no double counting of resources).

ME1/1

- No need for common planning at this stage

CSC Commissioning – Phase I


G.Apollinari, O.Prokofiev
FNAL, July 7, 2003

Proposal

EndCap Muon System

Maintenance and Operation

Chamber Tests in SX5

1. Introduction

2. Tooling

Draft

- **Status (more specific)**
  - No broken wires on all YE+2 installed CSCs (36 chambers)
  - Checked all gas pipelines in YE+2
    - Found & Corrected 4 labeling mistakes, Hardware OK
  - Checked leak rate for 4 CSCs
    - All within specs
- **Plans (immediate future)**
  - Complete previous tests on all YE-2 & YE+2 CSCs by end of October (72 ME/2+18 ME2/1)
  - Start Cable/Connectivity & Dead Channel Cross-checks on *"cabled"* CSCs with portable DAQ system.
    - Provide quick feed-back to Installation crew.

CSC Commissioning – Phase II

Goals

- Extended FEE Checking, Timing and Debugging. Extended HV testing of CSCs. Achieve 100% working channels (FEE+HV sectors)
  - Longish (~few hours to a day) test of CSCs at working voltage (3.6 kV)
  - Extended test of FEE using procedures developed at FAST sites (see next slide).

Planning/Status

- Plan being developed. Subset of FAST site tests will be used in order to commission ~2-3 CSCs/day. Expected ~60-90 days per endcap (3-5 months).
- Portable Standalone DAQ system being commissioned to deal with different cable lengths (UF).

Needs & Human Resources

- Access to disk (coordinated through the CSC Installation Group) + Working gas mixture delivered to disks. Portable DAQ & Power Supplies. No water.
- US-EMU - (UF, Purdue, UCLA, UC Davis, PNPI *(ME23/1)*, IHEP *(ME23/1)*).

ME1/1

- DAQ development will include the ME1/1 cable lengths.

CSC Commissioning – Phase II

- **Considerations for "FAST site" testing of CSCs on disks**
  - Implemented for Phase I @SX5
  - Planned for Phase II @ SX5. Still ~unsatisfactory timing.

1→ Broken wires
2→ Cable connectivity/Dead Channels
3→ Gas leak

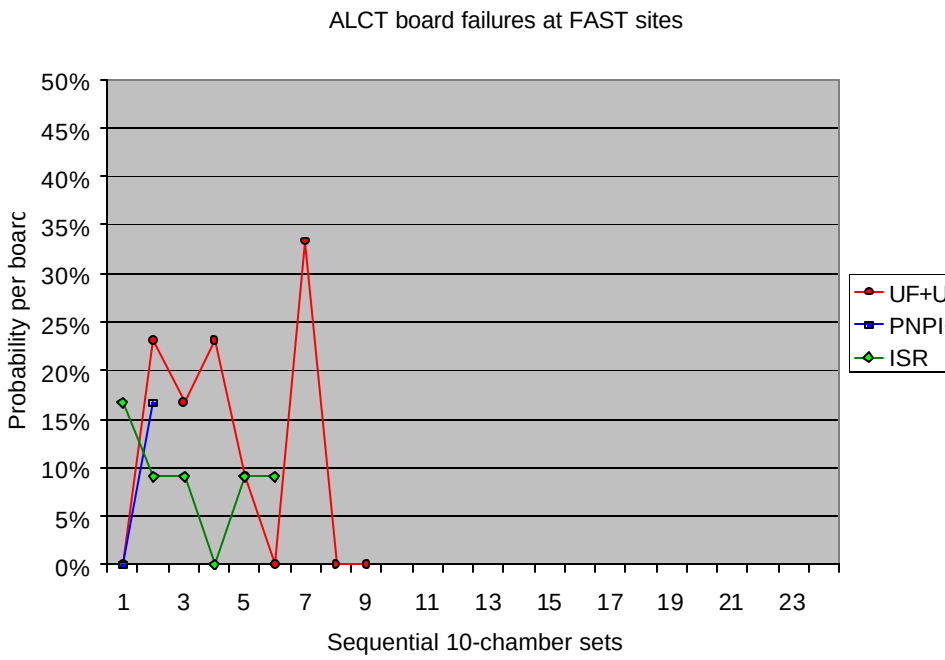
.....		Timing
9→	Initialization, Slow Control Test (ALCT, LVMB, CFEB)	25 min
0	Qualitative test (event display)	
1→	AFEB counting rate, after-pulsing, interconnections (3600 and 3800 V)	20 min
2→	AFEB connectivity, cabling check, cross-talks	3 min
3→	AFEB threshold calibration, analog noise	20 min
4	AFEB-ALCT time delay calibration	
5→	CFEB noise/pedestals, SCA pedestal uniformity, readout-correlated cross-talks	10 min
6→	CFEB connectivity, cabling check	3 min
7	CFEB pulse timing, shape quality, near-strip and long-range cross-talks, gain calibration	
8→	CFEB comparator counting rate (3600 and 3800 V)	20 min
9→	CFEB comparator threshold calibration, analog noise	35 min
0	CFEB comparator timing	
1	CFEB comparator logic check	
3→	CFEB comparator offsets and analog noise: (n+1)-(n) and (n+1)-(n-1)	110 min
.....	**Total**	**246 min** ☹

CSC Commissioning – Phase II

Expectations for "FAST site" testing of CSC+FEE in SX5

- CSCs + FEEs processed by Production FAST sites should be "problem-free" at ISR.
- Unfortunately this is not the case even though the "problem rate" is considerably reduced (see picture)
- Several of the ISR problems appears to be due just do mishandling (but they are "problems" nevertheless)

It is reasonable to expect a non-zero failure rate for CSC+FEE installed in SX5.



- **FEE Failure rates experience:**
  - UF/UCLA ~3.4% of boards
  - PNPI/IHEP ~2.0% of boards
  - ISR ~1-1.5% of boarc
  - SX5 ??

CSC Commissioning – Phase III

Goals

- Readout multiple chambers on one disk through one peripheral crate.
- Commission HV, LV and respective Slow Controls (see Clare's talk).

Planning/Status

- No full plan yet, but a lot of software development work going on, XDAQ-based DAQ being developed at UF and at the CERN 25 nsec test beam (Sep '03).
- Peripheral Crate Commissioning will naturally evolve into the *"Slice Test"*
  - Commissioning will be performed on 100% of the system
  - *Slice Test* will exercise a ϕ sector of 20^0 in the EMU system.

Needs & Human Resources

- Availability of Peripheral Crates & Electronics (delivered in ~Summer '04)
- Access to disk (coordinated through the CSC Installation Group) + Working ga mixture delivered to disks. HV and LV delivered to EMU-CSC.
- US-EMU - (Rice, UF as software developers – usual suspects at CERN).

ME1/1

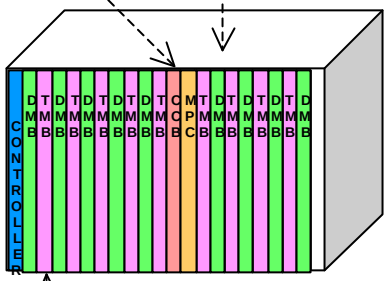
- Software and Hardware provided to - manpower provided by - the ME1/1 grou

CSC Commissioning – Phase III
Crates Nomenclature

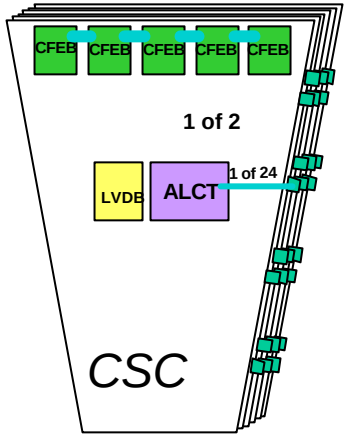
Peripheral Crate on Disk

475 Trig Motherboard

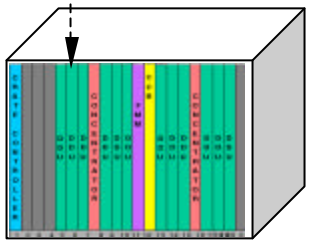
8 Clock Control Board



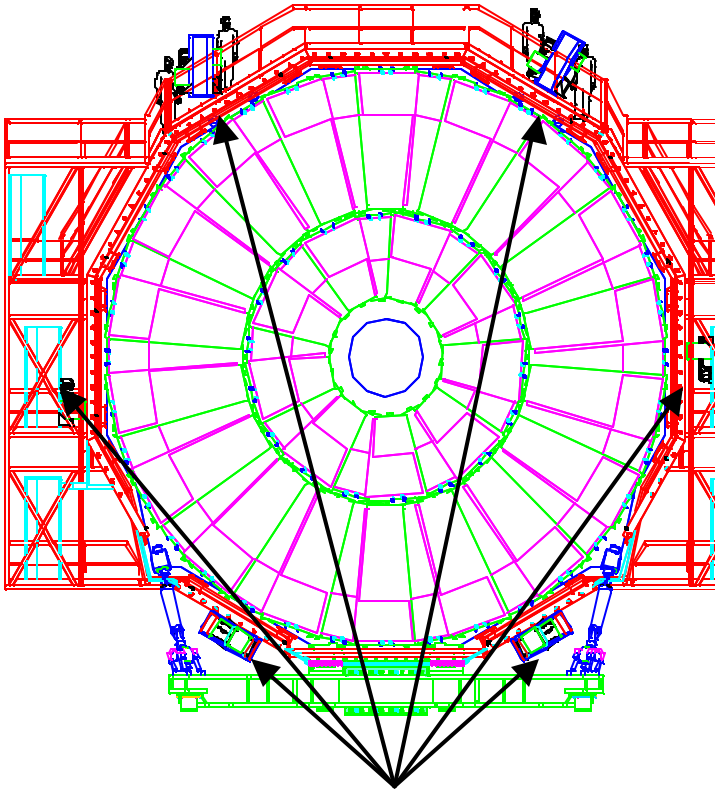
75 DAQ Motherboard



40 DDU Board

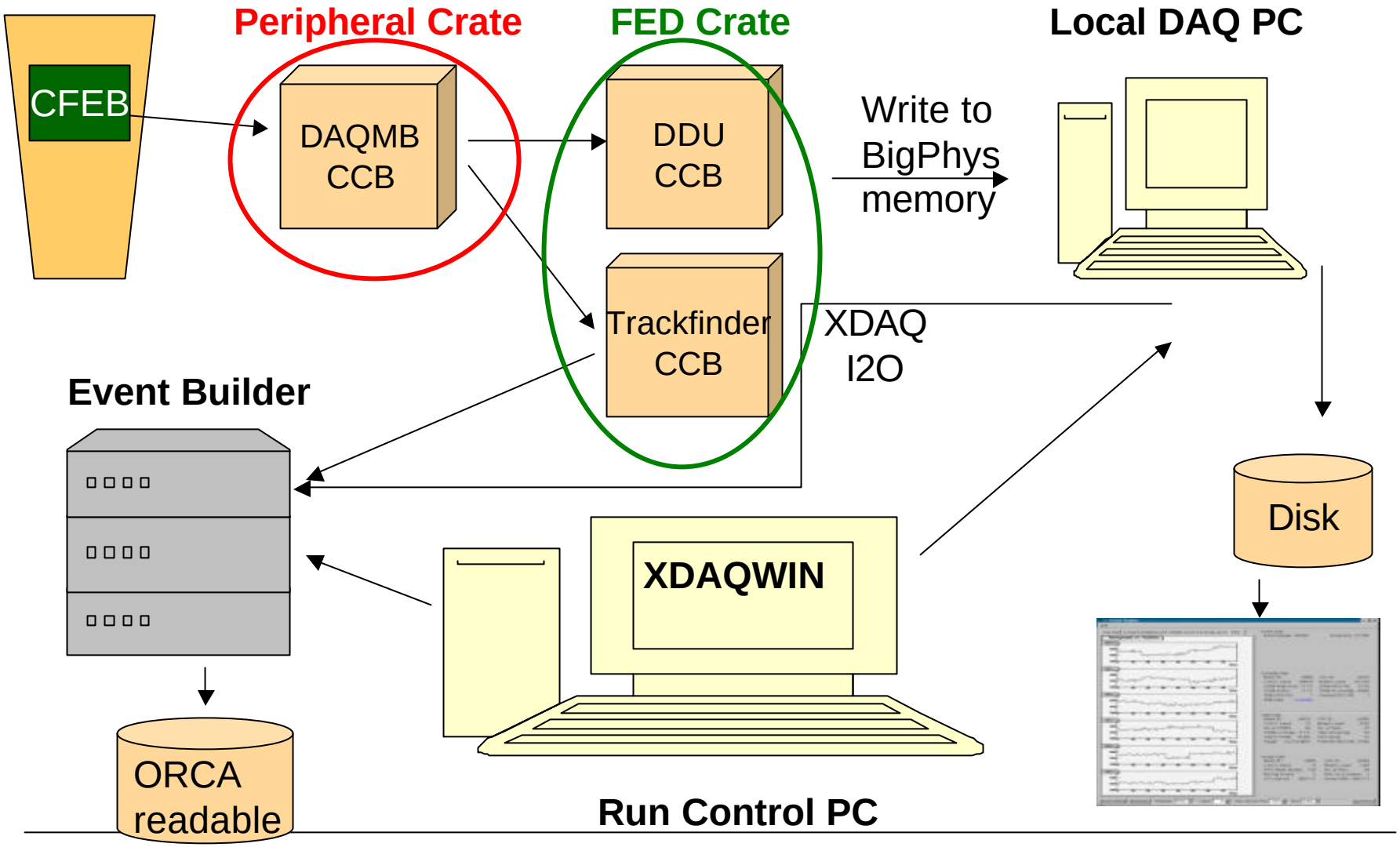


FED Crate in USC55



Peripheral Crates

CSC Commissioning – Phase III Data Flow



CSC Commissioning – Phase III Present Thinking (under evolution)

Slice Test *"Detour"*

- Start with a 20^0 sector of ME2/2 Chambers
- 2 ME234/2 CSCs mounted on YE+2
  - 1 CSC belongs to the "lower layer" CSCs.
  - The second CSC can be temporarily installed, if necessary, even if the ME2/1 chambers are not installed yet.
- Temporary "Peripheral crates" can be installed if necessary. Peripheral Electronics (DMBs, TMBs) from production.

Achieved with preproduction hardware in UF (Aug. '03)

- FED crate still "simulated" in software

- FED Crate sitting at the foot of the disk

Full Commissioning

- Will use subset of the "Slice Test" measurements.
- Performed on 100% of the system after production crates and boards are installed.

CSC Commissioning – Phase IV

Goals

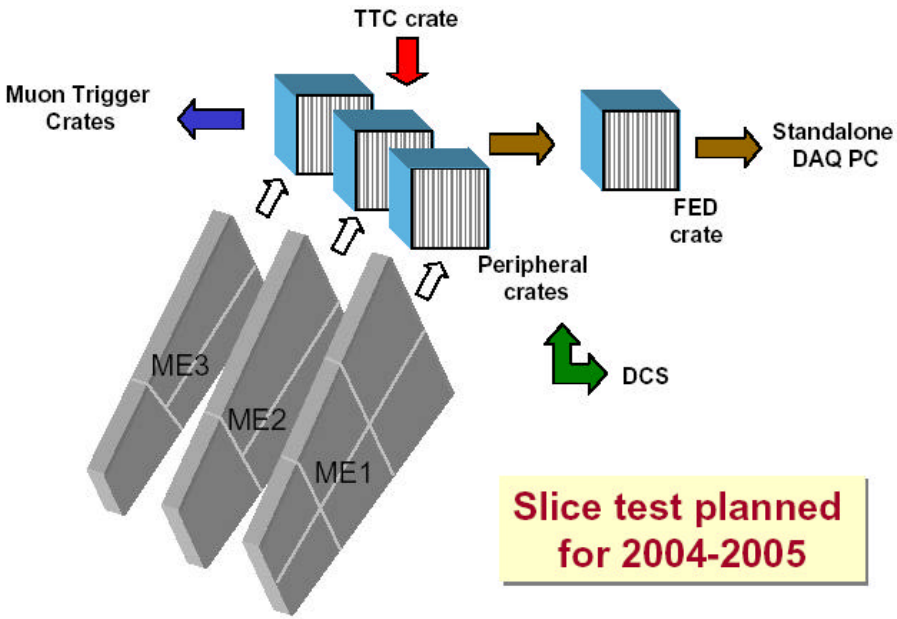
- Readout multiple disks disk through Peripheral crate and FED Crates (USC55).
- Phase IV corresponds to the natural definition of a Slice Test.
  - Tight connections with Trigger system.
- Phase IV to take place both in SX5 and UX5.

Planning/Status

- No plan yet. FED Crates hardware becoming available in prototypes, but hardware not yet systematically used in CSC readout.

ME1/1

- Full integration of the EMU system at this stage.



Commissioning Manpower

How much manpower (physicists excluded) is needed ?

- Use CDF Commissioning experience
- Largest needs during the Commissioning phase:
  - Electrical/Electronics Engineers & Software Engineers.

- Example of consideration for CMS-EMU Electronics.
  - CDF used 2.5 FTE-y of El.Eng. for the Commissioning of ~400 complex VME Boards
  - US-EMU system will have to commission ~3000 complex VME boards and there is funding available for 11 FTE-y of El.Eng. (~70% of CDF experience, comparable but on the low side).
- Similar considerations apply to funding for Software Engineers.

Commissioning Milestones/Activitie

Slice Test in SX5	**Oct 1st, 2004**
YE+ Operations in SX5	**March 1st, 2005**
YE- Operation in SX5	**Sep. 1st, 2005**
Re-Commissioning in UX5	**Oct 1st, 2005 to Apr. 30th, 2006**

Conclusion

- **Lacking unlimited financial and/or manpower resources, it takes ~2-3 years for a detector system to go from the "Installation" phase to a "Ready for Physics Data Taking" phase (CDF-D0 experience).**
- **EMU in good shape.**
  - Installation taking place.
  - Phase I Commissioning steps being undertaken.
  - Procedures and tools for Phase II inherited from FAST sites and almost ready to be used in SX5.
  - Phase III (*Slice Test*) software tools being developed. Hardware delivery on schedule for Slice Test goal date (Fall '05).
  - Next hurdle: start Chamber+Electronic read-out in SX5 and share the Hall with the rest of the CMS assembly work.